(c) REMARKS

The claims are 1, 10, 11, 15, 24 and 25, with claims 1 and 15 being independent. Claims 1 and 15 have been amended to better define the intended invention. Support for the amended claims is found, inter alia, on page 17, line 22 to page 18, line 13, Example 1 and Comparative Example 1. When electron number density decreases to one-tenth (i.e. 10%) of that of the plasma, then it is reduced 90% from the electron number density in the plasma.

Claims 1, 6, 8, 12-15, 20, 22 and 26-30 were rejected as obvious over Tanimura '175, in view of Ikeda '748 and Tomoyasu '103. Claims 10, 11, 24 and 25 were rejected as obvious over Tanimura '175, in view of Ikeda and Tomoyasu '103 and further in view of Kanai '257. The rejections are respectfully traversed.

Prior to addressing the grounds of rejection, Applicants wish to briefly review certain key features and advantages of the present claimed invention. The passage "blocking plasma in the processing space from reaching the chemical-reaction inducing means via said plasma blocking unit" in step (c) of claims 1 and 15 provides that the chemical-reaction inducing unit is arranged at a position reachable by plasma generated in the processing space. The plasma blocking unit is arranged between the processing space and chemical-reaction inducing unit to block the plasma from reaching the chemical-reaction inducing unit.

A plasma may be deemed "blocked" when residual plasma measured beyond the blocking means has a reduced electron density of 10% or less of the electron density of plasma generated in the processing space. See page 18, lines 8-13. The claims have been amended to recite this feature.

Generally, it is preferable that chemical-reaction inducing treatment is conducted at a position relatively close to the processing space. If the treatment is carried at a position farther from the processing space, then polymerized by-product (for example, polysilane) tends to deposit unduly and shut the exhaust line (pipe), thereby making it difficult to exhaust the gas.

However, if the chemical-reaction inducing unit is simply arranged closer to the processing space, then plasma readily extends to the chemical-reaction inducing unit. Such plasma not only acts to decompose polymerized by-product, but also generates further by-product, thereby reducing the overall decomposition performance.

The present invention solves the above problems by so arranging a plasma blocking unit to prevent most of the plasma from the processing space from interfering with the chemical-reaction inducing unit. This permits the chemical- reaction inducing unit to effectively remove unreacted gas and by-products generated by the plasma in the formation of the deposited film as a hard film. Further, the plasma-blocking unit acts to prevent corrosion of the exhaust pipe, valves and exhaust pumps. In addition, deposition of by-product is reduced which decreases the frequency of long-term maintenance and simplifies and improves the life of the apparatus. Finally, the combined action of the plasma-blocking unit and chemical-reaction inducing unit effectively removes unreacted gas and by-products generated when a film having a large area is formed at a high rate for a long time, without an adverse effect on the deposited film.

Shoichi Tanimura (Tanimura), JP04-136175, the primary reference, discloses that a reaction chamber is provided in an exhaust pipe for processing any unreacted gas in the exhaust gases. Specifically, Tanimura discloses that a quartz plate and

a heater are provided within the reaction chamber. However, Tanimura does not disclose that the reaction chamber is provided at a position adjacent a processing chamber which is subject to the action of the plasma. Tanimura discloses only use of a chemical-reaction inducing means composed of a quartz and a heater.

However, Tanimura does not disclose a plasma blocking unit of the present invention. Therefore, if the Tanimura "reaction chamber" is provided at a position reachable by plasma from the processing chamber, then its ability to process by-product will be severely reduced. Accordingly, Tanimura cannot be employed in an apparatus for forming a deposited film under stringent conditions, where a relatively large amount of by-products are generated.

On the other hand, should the reaction chamber in Tanimura be spaced at a position farther from the processing chamber where the plasma does not extend, then excess by-product is deposited between the processing chamber and the reaction chamber. In this embodiment, the Tanimura apparatus fails because by-products are deposited to a significant degree.

Ikeda , JP8-299748 (Ikeda) merely discloses that a heating trap means is provided in an exhaust passage and that an electro-thermal coil is specifically used as the heat trap. However, Ikeda does not disclose that a reaction chamber must be provided at a position sufficiently close to a processing chamber to prevent deposition of by-product. Ikeda only discloses a chemical-reaction including means comprising an electro-thermal coil. Ikeda does not disclose that by-product is more efficiently processed when a blocking means is spaced to prevent process plasma from reaching the chemical-reaction inducing means.

If the Ikeda reaction chamber is provided at a position which is reachable by plasma from the processing chamber, then its ability to process by-product is substantially reduced. Therefore, the Ikeda reaction chamber cannot be applied close to an apparatus for forming a deposited film under the severe conditions, where a relatively large amount of by-products are generated. On the other hand, where the Ikeda reaction chamber is provided at a position farther from the processing chamber, beyond the reach of the process plasma, then substantial amounts of by-product are deposited between the processing chamber and the reaction chamber. In this case, Ikeda is not effective to reduce large quantities of by-product.

Tomayasu, USP 5,900,103 (Tomayasu) discloses a processing apparatus for conducting plasma processing or etch processing. A plasma is uniformly generated by arranging a baffle plate 326 having a plurality of holes at a position opposite to upper electrode 330, applying a high-frequency power to baffle plate 326 and setting the voltage of the baffle plate to the same voltage as susceptor 305. The Examiner argues that the baffle plate of Tomayasu corresponds to the plasma blocking means of the present invention . However, baffle plate 326 is quite different in kind from the plasma blocking unit of the present invention. Further, Tomayasu teaches nothing of reducing the electron number density in plasma reaching a chemical-reaction inducing unit by at least 90%.

Baffle plate 326 is apparently arranged at a position where the processing space and the exhaust line (pipe) are divided. The processing space and the exhaust line communicate with each other through a plurality of holes. However, since the baffle plate is connected to a high-frequency electrode, as is clearly seen from Fig. 13, then, when the baffle plate is made of aluminum or stainless steel, it is difficult or even impossible to set

the baffle plate to a ground potential. A high-frequency power is applied to baffle plate 326 and to upper electrode 330 to set the baffle plate 326 and the upper electrode 330 to the same potential. The baffle plate 326, itself, acts more as a high-frequency electrode, likely to generate a plasma itself. Therefore, the baffle plate cannot be used as a plasma blocking means.

The object of arranging the baffle plate 326 of Tomoyasu et al. is to actively deposit a reactive product (corresponding to a by-product in the present invention) on the baffle plate 326. As occasion demands, the baffle plate 326 having the attached reactive product is detached and cleaned by etching. In other words, the baffle plate 326 of Tomoyasu et al. is effective only in a processing apparatus in which a relatively small amount of a reactive product is generated. When conducting lengthy processing on a substrate having a large area, or when conducting processing when generating a large amount of a by-product (for example, under condition of forming a microcrystalline silicon film at a large rate), the holes of the baffle plate 326 are closed rapidly by deposited by-product and the processing cannot be continued. There is no reason to speculate that plasma flow could be reduced 90% in the region after the baffle, since the baffle can generate plasma itself.

Further, Tomoyasu discloses nothing as to use of a chemical-reaction inducing unit.

In the present invention, the chemical-reaction inducing unit is provided at a position where plasma of the processing space reaches and the plasma blocking unit is arranged at the position to block the chemical-reaction inducing unit from the plasma, thereby making it possible to effectively conduct the processing even when generating a

large amount of by-product. Accordingly, since the above-described references disclose and suggest different objects, features and effects as described above, there is no motivation to combine the references. Even if, arguendo, motivation be deemed to exist to combine the references, the baffle plate of Tomoyasu, itself, most likely acts as a high frequency electrode to generate plasma, and, therefore, the baffle plate cannot be the plasma blocking unit. Under certain conditions in Tomoyasu, plasma is always generated.

Therefore, even if the Tanimura and Ikeda references are sought to be combined with Tomayasu , the Tomoyasu baffle plate, itself, generates plasma and would not sufficiently protect the chemical-reaction inducing unit. One would create the very problem solved by the present invention.

Kanai, USP 5,976,257 (Kanai), discloses that plasma is confined with mesh. However, Kanai relates to microwave plasma CVD. The pressure for forming plasma in the microwave plasma CVD method of Kanai (several mTorr to several tens of mTorr) is lower by 2 to 3 powers of ten than that of the RF plasma CVD method. Therefore, by-products, such as polysilane, are barely formed in Kanai (see column 4, lines 25-39 and the Example). Accordingly, Kanai does not disclose the problem to be solved by the present invention.

Wherefore, it is submitted that none of the references, whether alone or combined, discloses or suggests the present claimed invention, nor renders it unpatentable. The claims should be allowed and the case passed to issue.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our below listed address.

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